Non-Lethal Electronic Perimeter Fencing - A New Alternative for Force Protection

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Non-Lethal Electrified Perimeter Fencing - A New Alternative for Force Protection

From the time we were small children, we were taught to fear electricity. As we grew up, our minds continued to absorb stories of death by electrical shock caused by faulty appliances, downed power lines or lightening strikes. This fear is part of our psyche. The fear of electricity, particularly high voltage electricity, is now being used to design more efficient outdoor perimeter security systems.

Several years ago, the California Department of Corrections (DOC) did an exhaustive nationwide study of the effectiveness of electronic perimeter security. The study was motivated by their exploding prison building program and the high manpower costs of correctional officers. At the time, every medium and maximum security prison had electronic perimeter security but they also had manned towers every 500 feet around the perimeter. They considered the electronic perimeter systems to be too unreliable to operate without these guard towers.

The high cost of manning these towers, 24 hours a day, 7 days a week, was not cost effective. The California DOC decided on a bold approach. They would install a perimeter system that incorporated a lethal electric fence, an array of horizontal wires 12 feet high that held a 5000 Volt potential. Anyone or anything that touched this array was doomed to electrocution.

They engaged a prominent A&E firm to turn this concept into a practical operating system. The result was a sophisticated perimeter security system that met all of the basic requirements of Deterrence, Detection and Delay. I had the dubious pleasure of being heavily involved in the prototype installation in Southern California.

The system worked so well and the deterrence was so high that they were able to de-man their guard towers. The manpower savings paid back the one million dollar cost of the system in 9 months. The use of lethal electric fencing has not only expanded throughout all of the high-risk facilities of California, but is also becoming a standard in other States as well.

No system is without problems. One unexpected problem revealed itself after several months of operation. Birds were being killed. A large bird landing on one wire and coming in contact with an adjacent wire was summarily electrocuted. Steps have been taken to correct this but it is expensive.

To protect the prison staff and general inmate population, the lethal array is constructed within a no-mans land between two 12-foot chain link fences. An inmate has to have a suicidal mind-set to come in contact with the high voltage.

As effective as these systems have been for prisons, they have limited use in other perimeter security applications. Now, a variant of this technology has been introduced and is finding wide acceptance by State correctional agencies as well as other security applications.

Various types of non-lethal electric or “stun” fences have been used worldwide for many years. The agricultural version, a single wire of high voltage that helps to contain corralled horses and other livestock, is one example. The 5000 + Volt potential is still used but occurs in pulses, typically one per second. The pulse is only a few milliseconds in length.

If you have ever touched a dirty spark plug wire, you know the feeling of touching a stun fence. The extremely short pulse, while very uncomfortable to the touch, is not lethal or injurious because it lacks the energy to interrupt the natural electrical pulse that regulates the heart beat - in both man and animal. By contrast, a lethal fence has so much energy to dissipate that it has to use a saturable core transformer to limit current flow to 500 milliamps, well in excess of that required to cause heart fibrillation and death.

In both lethal and stun fences, the high voltage ensures that the human body’s resistance is overcome so as to permit the potential to find a path to ground. The pulse shock repels anything touching the wire fence. Conversely, the constant current of the lethal fence literally causes the hand muscles to contract onto the wires.

Birds or other animals that touch a hot wire and ground are likewise repulsed. The electronic monitor is programmed to alarm only if two consecutive pulses show a sharp voltage reduction. Since the first pulse repels the animal, the nuisance alarm is avoided.

Several other State correctional agencies are now turning to this non-lethal variant. It provides adequate deterrence and is a fraction of the cost of the lethal fence. Like the lethal fence, the configuration typically consists of a horizontal wire array. Often, it is attached to the inside of an existing fence. High voltage wires are intermixed with low voltage wires, both of which are identical in appearance. Random mixing of the wires makes it almost impossible to use a "jumper wire" to defeat the fence.

An alarm occurs when someone:

(1) Touches the wire and ground
(2) Touches both a high and low voltage wire or
(3) Spread the wires, causing two adjacent wires to touch each other or a grounded component. Cutting any wire causes the voltage to drop to zero also causing an alarm.

Each of these actions causes a rapid voltage drop that is detected by the monitoring circuits.

The alarm detection system continues to operate even if the high voltage feature is turned off. Contact between wires, cutting of wires or grounding of a wire will still activate an alarm in the low voltage mode.

False or nuisance alarms are rare. Weather phenomena that affect other sensors have no effect on the high or low voltage wires. Wind and electromagnetic interference have no effect, nor does rain, snow or ice. Because of their chemical purity, they are poor conductors.

Various levels of current leakage can occur when dust particles mix with dew or other forms of moisture. However, the monitoring circuit reacts only to a rapid voltage drop, nominally 20%. More advanced stun fences have digital circuitry that continuously sample the voltage of the returning pulse and adapt the alarm threshold accordingly. This not only eliminates nuisance alarms from moisture but from slow growing vegetation as well.

A stun fence is technically simple and inexpensive. It consists of a high voltage energizer, high and low voltage monitors and a wire array. (Figure 1) The wire array can take many forms and can be customized to suit the application.

The energizer utilizes a 12 Volt battery as a source of power. The battery is trickle-charged by either an AC to DC power supply or solar panel. To achieve the high voltage, the 12 Volts is fed through a 700 Volt, 11-microfarad capacitor circuit. When the capacitor reaches a certain charge, it discharges emitting a pulse of energy that flows through the primary of a transformer, the secondary of which has an output of 5000 to 9000 Volts.

This high voltage, 3-millisecond pulse, travels down a wire array and returns to an electronic monitoring circuit which analyses the voltage drop between the output and return pulses. A sharp 20% or more reduction between output and return creates an alarm condition. (The percentage drop is programmable.)

The low voltage wire is at the battery level. It acts as a grounding source for the high voltage wire. Since it is supervised, it also acts as a detector if grounded or cut.

Both hard steel galvanized and stainless steel wire may be used. The wire should be of a type that has both very low resistance as well as a very low coefficient of expansion. Barbed wire is generally not used. A person attempting to penetrate is likely to be stuck in the array and suffer injury rather than simply being repelled.

The energizer/monitor cabinet should be approved by appropriate international laboratories such as the United Laboratories. The laboratories certify the cabinets and their components only if they pass rigid electrical construction tests as well as other electrical tolerance and fail-safe tests. As an example, the energizer must shut down if the pulse values become erratic.

The stun fence not only provides high reliability and deterrence, it is also very flexible in application. It can rapidly be added to existing fences or constructed as a stand-alone barrier. The array can be as large as an entire fence or be placed on top of an existing fence with only the use of a few wires. It can be utilized on rooftops or laid out flat above the ground. (Figures 2, 3, 4 and 5) It can be suspended within rolls of barbed tape. It is terrain following. While normally used as a deterrent, it can also be deployed covertly. A single security zone can extend beyond to 1000 feet or further, depending on the number of wires in the array.

Finally, the stun fence can be integrated with existing alarm monitoring systems or utilize its own state-of-the-art color graphic PC and PLC based alarm and control system.

The applications for the stun fence, as it applies to Government agencies, are limitless. It is beyond the scope of this paper to list all of the Government outdoor assets that need perimeter protection. Nor is it possible to examine the many types of threats that must be considered. I can only encourage you to investigate this new perimeter security innovation. It is affordable, reliable and has the unique capability to provide both high deterrence and reliable detection.